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Promoting CPAP adherence in clinical practice: A survey of Swedish and Norwegian CPAP practitioners' beliefs and practices

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Summary

The benefits of continuous positive airway pressure (CPAP) treatment for obstructive sleep apnea are well established, but adherence tends to be low. Research exploring CPAP practitioners' beliefs around determinants of CPAP adherence, and the actions they use in clinical practice to promote CPAP adherence is lacking. This study aimed to: (i) develop and validate a questionnaire to assess beliefs and current practices among CPAP practitioners; (ii) explore practitioners' beliefs regarding the main determinants of patient adherence, and the actions practitioners most commonly use to promote CPAP adherence; and (iii) explore the associations between perceived determinants and adherence-promotion actions. One-hundred and forty-two CPAP practitioners in Sweden and Norway, representing 93% of all Swedish and 62% of all Norwegian CPAP centres, were surveyed via a questionnaire exploring potential determinants (18 items) and adherence-promotion actions (20 items). Confirmatory factor analysis and second-order structural equational modelling were used to identify patterns of beliefs, and potential associations with adherence-promotion actions. Patients' knowledge, motivation and attitudes were perceived by practitioners to be the main determinants of CPAP adherence, and educating patients about effects, management and treatment adjustments were the most common practices. Knowledge was shown to predict educational and informational actions (e.g. education about obstructive sleep apnea and CPAP). Educational and informational actions were associated with medical actions (e.g. treatment adjustment), but knowledge, attitude and support had no association with medical actions. These findings indicate that a wide variety of determinants and actions are considered important, though the only relationship observed between beliefs and actions was found for knowledge and educational and informational actions.

KEYWORDS
adherence, continuous positive airway pressure, obstructive sleep apnea, patient education

1 | INTRODUCTION

The treatment of choice in severe obstructive sleep apnea (OSA) is continuous positive airway pressure (CPAP). CPAP treatment may prevent the upper airway from collapsing, and can thus prevent both short-term and long-term negative effects of OSA (Fu et al., 2017). However, CPAP adherence tends to be poor, which is a major barrier to effective treatment (Campos-Rodriguez, Martinez-Alonso,

Sanchez-de-la-Torre, & Barbe, 2016; Henry & Rosenthal, 2013). Several studies have identified factors that might affect CPAP adherence, including aspects of treatment (e.g. type of mask, side-effects or use of a humidifier), disease characteristics (e.g. OSA severity indices, co-morbid insomnia, perceived symptom reduction), communication, as well as behavioural and motivational aspects (e.g. personality, habits, motivation and attitude; Broström, Fridlund, Hedberg, Nilsen, & Ulander, 2017; Broström et al., 2010; Drager et al., 2010; Ulander, Johansson, Ewaldh, Svanborg, & Broström, 2014; Ward, Hoare, & Gott, 2014). In turn, these factors have generated various interventions, ranging from developments in pressure titration (e.g. auto-CPAP versus fixed-pressure CPAP), to technical (e.g. Telemedicine and Mobile Health Applications) and educational and behavioural interventions (Bartlett et al., 2013; Deng, Wang, Sun, & Chen, 2013; Hevener & Hevener, 2016; Hwang, 2016; Lai, Fong, Lam, Weaver, & Ip, 2014; Olsen, Smith, Oei, & Douglas, 2012; Stepnowsky, Edwards, Zamora, Barker, & Agha, 2013; Wozniak, Lasserson, & Smith, 2014).

However, effective interventions are not necessarily widely implemented or used in clinical practice. Due to a lack of transparency and absence of guidelines, much CPAP treatment practice is likely to be based on aspects of the local context, including preferences of the individual physician, or those of other decision-makers who meet the patients (e.g. nurses or technicians) within CPAP clinics. This means that there can be a gap between research-informed practice, as described in the literature, and actual clinical practice provided in CPAP clinics. Such "knowing-doing" gaps have been shown to be common in many areas of health care (Nilsen, 2015). While such a gap can be assumed to exist with regard to CPAP treatment practice, the extent to which regular clinical practice might differ from evidence-based practice has not been studied.

Achieving an evidence-based CPAP treatment approach may require the study of existing real-world clinical practice, by investigating what practitioners are currently doing to promote CPAP treatment adherence in their patients, and why. However, no validated measure exists to measure this. This study had three aims: (i) to develop and validate a questionnaire to measure beliefs and current practices among CPAP practitioners; (ii) to explore what the practitioners believe to be the main determinants of patient adherence, and the actions they commonly used to promote CPAP adherence; and (iii) to explore associations between perceived determinants and adherence-promotion actions.

2 | MATERIALS AND METHODS

2.1 | Design and population

A cross-sectional national survey design was used. All practitioners identified in national registers as working with CPAP treatment in Sweden (N = 174) and Norway (N = 98) were invited to participate. There are 45 CPAP clinics per 9.8 million inhabitants in Sweden, and 21 clinics per 5.2 million inhabitants in Norway. Inclusion criteria were that the participating practitioner should work clinically with CPAP initiation and/or treatment, either as a physician, nurse, physiotherapist, medical laboratory scientist or enrolled nurse. Staff without clinical encounters with patients (e.g. only with administrative tasks) were excluded.

Potential participants were initially sent, directly to their professional email address, a message describing the study, and announcing imminent postal delivery of study questionnaires. Two weeks later, postal questionnaires were dispatched. Up to two reminders were sent to practitioners, the first via email after 3 weeks, and the second by regular mail 2 weeks later. The sample and routines for CPAP initiation at the included clinics are presented in Table 1.

2.2 | Development of the questionnaire

In the first step, potential determinants were identified for inclusion in the questionnaire based on the authors' own clinical experiences, and a synthesis of primary qualitative and quantitative studies, and reviews and theoretical studies describing factors of importance for CPAP adherence (Broström et al., 2010; Campos-Rodriguez et al., 2016; Epstein et al., 2009; Henry & Rosenthal, 2013; Karlsson, Elfström, Sunnergren, Fridlund, & Broström, 2015; Olsen, Smith, Tian, & Douglas, 2010; Ward et al., 2014; Wozniak et al., 2014). In the second step, the Theoretical Domains Framework (Cane, O'Connor, & Michie, 2012) was used to organize the identification of potentially relevant perceived *determinants* of patients' CPAP use (i.e. factors deemed by the practitioner to be of importance in generating CPAP adherence in patients) or *actions* (i.e. practices adopted by the practitioner to encourage CPAP adherence in patients) potentially applicable to the context of CPAP adherence, as identified at the previous step. The Theoretical Domains Framework was deemed appropriate as it offers a comprehensive account of all determinants of behaviour as synthesized from numerous behaviour change theories (Cane et al., 2012).

These knowledge sources generated an initial 40-item questionnaire. These items were equally divided into two subscales describing determinants and actions, respectively. Actions were further divided into "educational and informational actions" (e.g. seeking to increase patients' knowledge about OSA and CPAP) or "medical actions" (e.g. treatment adjustment). To verify face and content validity, the 40 items were assessed by three independent nurse researchers with clinical experience and knowledge of OSA/CPAP treatment and expertise in questionnaire development. After a consensus decision, two items were deleted as they were deemed to lack validity to adequately assess the intended determinants. The comprehensiveness of the remaining 38 items, as well as the readability, clarity and layout of the questionnaire, was verified by two nurses working with CPAP treatment. A five-point Likert-type scale (1–5) was applied for each item, with higher scores indicating a stronger perceived influence of each hypothesized determinant (1; not important–5; very important), or a more frequently adopted action (1; never–5; always).

The initial questionnaire was generated in Swedish. The following steps were taken to ascertain equivalence when translating the questionnaire into English and Norwegian (Jones, Lee, Phillips,

TABLE 1 A description of the practitioners (n = 142) and initiation routines used at the CPAP clinics

Variables	
Practitioners/country, *n* (%)	
Sweden	97 (68)
Norway	45 (32)
Age	
Mean years (*SD*)	48 (10.5)
Sex, *n* (%)	
Women	121 (85)
Men	21 (15)
Occupation, *n* (%)	
Nurses	104 (73)
Technicians	13 (9)
Physicians	10 (7)
Nurse assistent	12 (8)
Physioterapeut	3 (2)
Experience, m (*SD*)	
Years in profession	20.9 (15.1)
Years in CPAP care	8.5 (6.9)
Clinic, *n* (%)	
Pulmonology	46 (32)
Ear-Nose-Throat	49 (35)
Sleep medicine	20 (14)
Other	27 (19)
Hospital, *n* (%)	
County council	83 (58)
University	37 (26)
Private	22 (15)
CPAP initiations per week, m (*SD*, range)	12.4 (14.7, 1–90)
Time per patient (min), m (*SD*, range)	57.4 (31.9, 6–360)
Titration procedure, *n* (%)	
Individual	120 (85)
Group	22 (15)
Mode of information delivery, *n* (%)	
Oral	135 (95)
Written	110 (77)
Video/DVD	11 (8)
Internet	5 (4)

CPAP, continuous positive airway pressure.

Zhang, & Jaceldo, 2001). First, two external bilingual individuals (i.e. one healthcare practitioner and one lay person) examined and approved the conceptual structure of the Swedish text. Next, three of the authors translated the scale into English. The English translation was examined by a behavioural scientist with English as first language, a bilingual group consisting of three sleep experts (i.e. physician, nurse and technician) fluent in Swedish and English, as well as three bilingual nurses, who proposed only a few minor wording modifications. One of the authors and an external bilingual individual then translated the scale back into Swedish. Finally, the back-translation was carefully examined by the external bilingual group, which judged it to be equivalent to the original text. The Norwegian version was translated from Swedish into Norwegian by a professional translation company, and verified as accurate by a Norwegian physician and a Swedish nurse working with CPAP initiation with knowledge of both languages. The items are presented in Tables 2 (i.e. determinants) and 3 (i.e. actions).

Demographic data (age, sex, occupation, clinical experience, type of clinic and hospital), as well as CPAP treatment procedures used in the daily routine work at the clinics (i.e. number of CPAP initiations per week, used time per patient, clinical CPAP titration routines, and mode of information delivery) were also collected.

2.3 | Statistical processing and analysis

Variables were normally distributed and analysed using parametric statistical tests. The *validity* of the measures was assessed in three steps: (i) testing of factor structure; (ii) examination of convergent validity; and (iii) assessment of discriminant validity. The *reliability* of the measures was assessed using composite reliability based on techniques proposed by Fornell and Larcker (1981). Coefficient alpha relies on equal loading for all the items of a subscale and is influenced by the number of items, whereas composite reliability combines all true score variances and co-variances in the composite of indicator variables to compute factor scores. Therefore, we believe that using composite reliability is more appropriate than using Cronbach's α (Raykov, 1998). Values of 0.7 or above indicate satisfactory reliability (Hair, Anderson, Tatham, & Black, 2005).

2.3.1 | Factor structure of a model including determinants and actions for CPAP adherence

A theoretical model of determinants and CPAP adherence-promotion actions was developed prior to the start of the study by a group consisting of sleep physicians, sleep researchers, CPAP nurses and behavioural scientists, based on previous literature and clinical experience. According to the model, practitioners' beliefs regarding determinants of CPAP adherence, including items focusing on knowledge and attitude, would influence actions used to promote CPAP adherence (Figure 1).

Confirmatory factor analyses (CFA) were performed to verify the factor structure of the hypothesized model. Due to the ordinal nature of the data, weighted least-squares estimation was applied to all CFA models, using the polychoric correlation matrix and the asymptotic co-variance matrix as input for the analyses. Items having a critical ratio greater than 1.96 are considered significant, indicating that the item could effectively be discriminated. Model fit was evaluated using root mean square error of approximation (RMSEA), goodness-of-fit index (GFI), comparative fit index (CFI) and incremental fit index (IFI). GFI, CFI and IFI values range from 0 to 1, where values greater than 0.90 typically reflect acceptable fit (Marsh, Hau, & Grayson, 2005). RMSEA values lower than 0.1 indicate a good fit (Browne & Cudeck, 1993).

TABLE 2 Item content, response frequencies and reasons for item exclusion on the subscale for determinants (n = 142)

Items	Not important	Slightly important	Moderately important	Important	Very important	Reasons for item being excluded or retained
1. Knowledge about sleep apnea	0%	1%	3%	26%	70%	Retained
2. Knowledge about the treatment	0%	1%	4%	19%	75%	Retained
3. Absence of negative social consequences of sleep apnea	0%	2%	13%	39%	45%	Excluded due to (MI = 16.74, EPC = 0.42, r = .51)
4. Absence of negative social consequences due to the treatment	1%	9%	44%	32%	14%	Retained
5. Belief in one's capability to manage the treatment	0%	1%	8%	45%	45%	Retained
6. Realistic expectations for the treatment	0%	1%	9%	50%	40%	Retained
7. Positive attitude to the treatment	0%	1%	3%	26%	70%	Excluded due to (MI = 17.26, EPC = 0.36, r = .58)
8. Belief that the treatment will have positive effects over time	0%	1%	4%	32%	63%	Excluded due to (MI = 12.52, EPC = 0.32, r = .50)
9. Positive somatic effects of the treatment	0%	0%	1%	31%	67%	Retained
10. Absence of negative somatic effects of the treatment	1%	4%	20%	39%	35%	Retained
11. Motivation to carry out the treatment	1%	1%	2%	20%	76%	Retained
12. Purposeful planning of the treatment	1%	4%	17%	46%	32%	Retained
13. Maintained cognitive ability	0%	1%	13%	44%	42%	Excluded due to (MI = 22.41, EPC = 0.29, r = .59)
14. Support from healthcare	0%	1%	9%	31%	58%	Retained
15. Access to social support	0%	4%	29%	46%	21%	Retained
16. Concern for complications and other diseases caused by sleep apnea	0%	4%	27%	47%	21%	Excluded due to (MI = 10.31, EPC = 0.24, r = .49)
17. Absence of anxiety/worry in association with the treatment	0%	1%	22%	37%	40%	Excluded due to (MI = 19.28, EPC = 1.24, r = .50)
18. The patient having made the treatment into an automatic behaviour	0%	0%	9%	35%	56%	Excluded due to (MI = 14.63, EPC = 0.30, r = .54)

EPC, expected parameter change; MI, modification index.

2.3.2 | Item reduction

Hypothesized models of the clustering of *determinants*, and subsequent use of adherence-promotion *actions* did not show an acceptable fit to the data. Thus, following guidelines provided by Goetz, Lemetayer, and Rat (2013), some items were eliminated from both measures. Those items with conceptual and empirical overlap with other items were removed using a combination of the following statistical indices: (i) large inter-item correlations (values over 0.5), which indicate conceptual overlap with other items; (ii) modification index (MI) values over 10; (iii) expected parameter change (EPC) values over 0.2; and (iv) standardized residual co-variance values over 0.2.

2.3.3 | Convergent and discriminant validity

Convergent and discriminant validity of the measures was assessed using a multi-trait correlation matrix. Spearman correlation coefficients were computed to test whether each item correlated significantly with its parent scale, as corrected for overlap. A correlation of .4 or greater between an item and its scale was considered as evident of convergent validity (Fayers & Machin, 2000). Convergent validity was further assessed by computing the average variance extracted (AVE). Correlations between each item and other scales were also computed to assess discriminant validity (Fayers & Machin, 2000).

A second-order structural equation model (Koufteros, Babbar, & Kaighobadi, 2009) was used to assess relationships between hypothesized *determinants* of CPAP adherence and the CPAP adherence-promotion *actions* used in clinical practice. Moreover, direct and indirect effects of the determinants on each of the two types of action (educational and informational actions, medical actions) were examined. Full information maximum likelihood estimation was used to handle missing data. Bootstrapping was performed, with 1,000 replications, and considering confidence intervals, to test the robustness of the results.

3 | RESULTS

3.1 | Study population

Responses were received from practitioners in 93% and 62% of CPAP centres, representing 53% and 51% of all practitioners in Sweden and

TABLE 3 Item content, response frequencies and reasons for item exclusion on the subscale for actions (n = 142)

Items	Never	Seldom	Sometimes	Often	Always	Reasons for item being excluded or retained
1. Educate about causes of sleep apnea	4%	1%	6%	32%	56%	Retained
2. Educate about symptoms of sleep apnea	1%	2%	6%	30%	60%	Excluded due to (MI = 21.43, EPC = 0.41, r = .50)
3. Educate about consequences/complications of sleep apnea	1%	1%	4%	31%	62%	Excluded due to (MI = 24.41, EPC = 1.04, r = .61)
4. Educate about the implementation and effects of the treatment.	1%	0%	1%	18%	80%	Retained
5. Educate the patient in practical management of the CPAP	0%	1%	2%	16%	80%	Retained
6. Demonstrate the patient's own sleep recording and/or adherence data	1%	2%	14%	31%	51%	Excluded due to (MI = 11.17, EPC = 0.32, r = .58)
7. Persuade the patient to use the CPAP	1%	1%	17%	34%	46%	Excluded due to (MI = 22.43, EPC = 0.36, r = .60)
8. Create positive expectations concerning social consequences of the CPAP treatment	0%	3%	14%	40%	44%	Retained
9. Create positive expectations regarding somatic effects of the CPAP treatment	0%	1%	6%	34%	60%	Retained
10. Create negative expectations/concerns regarding social consequences of no treatment	7%	30%	41%	14%	6%	Retained
11. Create negative expectations/concerns regarding somatic effects of no treatment	6%	13%	40%	32%	9%	Excluded due to (MI = 20.33, EPC = 0.39, r = .52)
12. Create realistic expectations regarding the CPAP treatment	0%	1%	8%	47%	43%	Retained
13. Create a concrete plan for how the patient should use the CPAP	1%	10%	11%	32%	46%	Retained
14. Treat causes of anxiety/worry during the CPAP treatment	10%	36%	30%	17%	6%	Retained
15. Adjust the CPAP treatment	0%	1%	1%	29%	69%	Retained
16. Encourage the patient to modify the bedroom environment	8%	16%	32%	28%	15%	Retained
17. Encourage the patient to make the CPAP treatment into a habit	0%	0%	2%	33%	65%	Retained
18. Use positive examples or role models	2%	8%	29%	40%	21%	Retained
19. Encourage the patient's belief in his/her own capacity to manage the CPAP treatment	0%	1%	11%	43%	45%	Retained
20. Support and educate relatives	3%	17%	40%	28%	11%	Retained

CPAP, continuous positive airway pressure; EPC, expected parameter change; MI, modification index.

Norway, respectively. The mean percentage of practitioners recruited to the study from each centre ranged from 0% to 100%. The number of eligible practitioners at each centre varied considerably (from 1 in one centre, to 10 practitioners in another). The most common occupation was nurse, and most practitioners worked in county council hospitals. Demographic data and clinical initiation routines are shown in Table 1.

3.2 | Beliefs regarding determinants and use of actions

Factors deemed by participants to be important determinants of CPAP adherence among patients are described in Table 2. Most hypothesized determinants had high levels of endorsement (i.e. defined here as items with a rating of 4 [Important] or 5 [Very important] on a 1–5 scale). Only three determinants achieved an average score lower than 4 (i.e. 80% endorsement): in increasing order of endorsement rate, these were absence of negative social consequences due to the treatment (46% endorsement), access to social support and concern for complications (67% endorsement), and other diseases caused by sleep apnea (68% endorsement). Table 3 describes the actions taken by participants to promote CPAP adherence. The same patterns of endorsement were seen for actions carried out by practitioners to facilitate patients' adherence to CPAP treatment. Only six out of 20 actions reached less than 80% endorsement.

3.3 | Confirming the factor structure for the questionnaire

Confirmatory factor analyses supported the use of a three-factor measurement model to understand determinants (breaking down

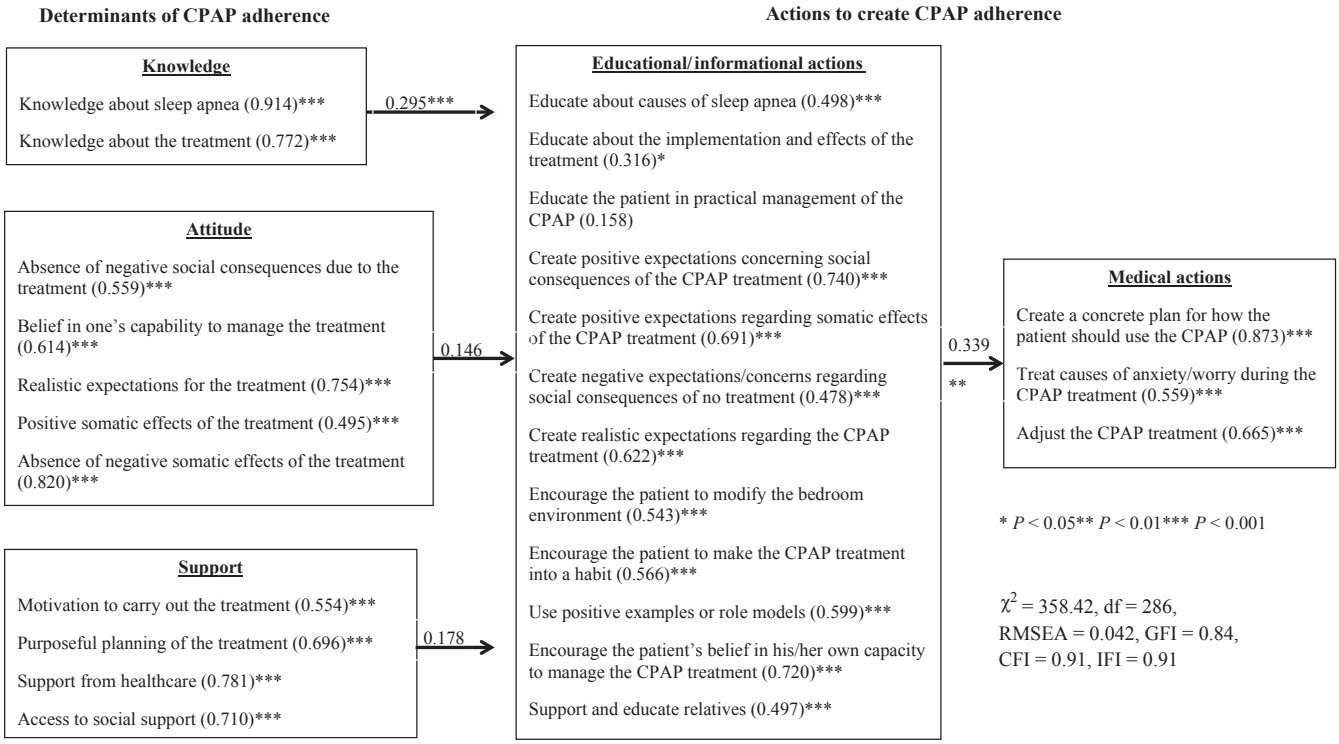

FIGURE 1 Second-order structural equation model of relationships between hypothesized determinants (i.e. factors for knowledge, attitude and support) and educational/informational actions and medical actions (n = 142). RMSEA, root mean square error of approximation; GFI, goodness of fit index, CFI, comparative fit index; IFI, incremental fit index

determinants into *knowledge*, *attitude* and *support*) and the two-factor measurement model for understanding actions (distinguishing between *educational and information actions* and *medical actions*; Table 4). For the three-factor measurement model, inter-factor correlations ranged from .55 (for attitude and knowledge) to .77 (for attitude and support). In the two-factor measurement model, the inter-factor correlation between educational and informational actions and medical actions was .57.

Item loadings were uniformly positive and the critical ratio for each loading was significant (p < .01). Both models achieved acceptable fit with the data (Table 4). The multi trait-scaling analysis showed that all items (i.e. determinants scale [Table 5] and actions scale [Table 6]) loaded higher on the construct on which they were designed to load (>0.40) than on other constructs. Composite reliability for each construct was above 0.70, and the AVE ranged from 0.32 to 0.68. Correlations among knowledge, attitude, support, theory and clinical practice are shown in Table 7.

3.4 | Relationships between determinants and CPAP adherence-promotion actions

Figure 1 shows the final second-order model for hypothesized determinants and actions to promote CPAP adherence. The model provided an adequate fit to the data (χ^2 = 358.42, df = 286, RMSEA = 0.042, GFI = 0.84, CFI = 0.91, IFI = 0.91) and explained 25% of the variance.

No direct relationship was found between hypothesized determinants (i.e. factors for knowledge, attitude and support) and CPAP-adherence actions (all p > .05) and their removal did not reduce the model fit ($\Delta\chi^2$ = 3.61, Δdf = 3, p > .10). Moreover, with the exception of knowledge (β = .30, p < .001), none of the hypothesized determinants predicted educational and informational actions. Educational and informational actions predicted medical actions (β = .34, p < .01). Knowledge was the only determinant to have an indirect effect on medical actions (β = .12, p < .001; all other p > .20). Sobel's test indicated that educational and informational actions acted as mediator between knowledge and medical actions (z = 2.70, SE = 0.04, p = .006). Bootstrap analyses confirmed that the analysis was not affected by the sample size.

4 | DISCUSSION

Our survey of most CPAP practitioners in Sweden and Norway showed that practitioners considered a wide variety of potential determinants of patients' CPAP treatment adherence to be important. Similarly, most possible actions to facilitate adherence were reportedly frequently used. Interestingly, of the perceived determinants measured, only the knowledge factor, i.e. the perception that patients' knowledge determines their adherence, influenced practitioners' use of educational and informational actions. Use of educational and informational actions in turn predicted use of medical

TABLE 4 Fit measures for the full and reduced models of determinants and actions scales (n = 142)

Model	Scale	Chi-square	*df*	RMSEA	90% CI	GFI	CFI	IFI
Determinants scale								
1	18 items with 3 factors	228.40	132	0.072	0.056–0.087	0.85	0.81	0.82
2	11 items with 3 factors	61.80	41	0.060	0.025–0.089	0.93	0.93	0.94
Actions scale								
1	20 items with 2 factors	401.16	169	0.099	0.086–0.111	0.74	0.65	0.66
2	15 items with 2 factors	92.39	89	0.016	0.001–0.049	0.91	0.94	0.95

CFI, comparative fit index; CI, confidence interval; GFI, goodness-of-fit index; IFI, incremental fit index; RMSEA, root mean square error of approximation.

TABLE 5 Item-factor correlations corrected for overlap for the determinants scale (n = 142)

Factors/items	Knowledge	Attitude	Support
Factor 1: Knowledge			
1. Knowledge about sleep apnea	0.81	0.16	0.29
2. Knowledge about the treatment	0.80	0.36	0.33
Factor 2: Attitude			
4. Absence of negative social consequences due to the treatment	0.19	0.66	0.40
5. Belief in one's capability to manage the treatment	0.28	0.67	0.41
6. Realistic expectations for the treatment	0.22	0.69	0.42
9. Positive somatic effects of the treatment	0.14	0.51	0.39
10. Absence of negative somatic effects of the treatment	0.24	0.73	0.51
Factor 3: Support			
11. Motivation to carry out the treatment	0.16	0.29	0.54
12. Purposeful planning of the treatment	0.33	0.51	0.77
14. Support from healthcare	0.41	0.43	0.68
15. Access to social support	0.22	0.45	0.73

TABLE 6 Item-factor correlations corrected for overlap for the actions scale (n = 142)

Items	Educational/informational actions	Medical actions
Educational/informational actions		
1. Educate about causes of sleep apnea	0.57	0.04
4. Educate about the implementation and effects of the treatment	0.43	0.02
5. Educate the patient in practical management of the CPAP	0.41	0.21
8. Create positive expectations concerning social consequences of the CPAP treatment	0.72	0.27
9. Create positive expectations regarding somatic effects of the CPAP treatment	0.60	0.24
10. Create negative expectations/concerns regarding social consequences of no treatment	0.50	0.15
12. Create realistic expectations regarding the CPAP treatment	0.55	0.30
16. Encourage the patient to modify the bedroom environment	0.58	0.30
17. Encourage the patient to make the CPAP treatment into a habit	0.51	0.24
18. Use positive examples or role models	0.66	0.27
19. Encourage the patient's belief in his/her own capacity to manage the CPAP treatment	0.64	0.32
20. Support and educate relatives	0.53	0.27
Medical actions		
13. Create a concrete plan for how the patient should use the CPAP	0.45	0.78
14. Treat causes of anxiety/worry during the CPAP treatment	0.17	0.76
15. Adjust the CPAP treatment	0.29	0.54

CPAP, continuous positive airway pressure.

actions, but knowledge, attitudes and support were not associated with medical actions.

The questionnaire used in the study was constructed by clinicians and researchers, and the items originated from clinical practice, scientific literature and theories of individual behaviour change (Cane et al., 2012). Behaviour change theories have previously been employed in CPAP adherence research (Stepnowsky, Bardwell, Moore, Ancoli-Israel, & Dimsdale, 2002; Stepnowsky, Palau, Gifford, & Ancoli-Israel, 2007). To function in a clinical CPAP treatment context, components of these theories needed to be contextualized and made as concrete as possible. During the initial development phase, questionnaire content and face validity was assessed by a multidisciplinary group of sleep physicians, CPAP adherence researchers, as well as clinically active CPAP practitioners. Items were removed from the questionnaire based on face and content evaluation, but also on model goodness-of-fit in combination with the conceptual content of the items. One limitation from a statistical point of view is that

TABLE 7 Descriptive statistics and bivariate correlations between the factors (n = 142)

	Knowledge	Attitude	Support	Educational/ informational actions	Medical actions	Mean (*SD*)	Composite reliability	AVE
Knowledge	1					4.68 (0.48)	0.80	0.43
Attitude	0.34	1				4.15 (0.49)	0.79	0.68
Support	0.40	0.62	1			4.26 (0.51)	0.75	0.48
Educational/informational actions	0.32	0.34	0.33	1		4.10 (0.59)	0.78	0.32
Medical actions	0.24	0.32	0.33	0.41	1	3.83 (0.63)	0.83	0.51

AVE, average variance extracted.
All correlations significant at $p < .01$.

one item in the action subscale (i.e. "educate the patient in practical management of the CPAP") was retained despite having a poor fit (Figure 1), as it was considered too conceptually important to remove. However, the developed questionnaire seems promising, with a sound three-factor structure for determinants (i.e. knowledge, attitude, support) and a two-factor structure for actions (educational and informational actions, medical actions). However, further tests are needed. In addition to further validating the questionnaire (e.g. assessing its test–retest validity), future studies might usefully explore the discrepancy between evidenced practice and beliefs about determinants and adherence-promotion actions used among CPAP practitioners. Objective CPAP adherence data can be used to assess convergent and discriminant validity.

The scientific literature offers recommendations regarding CPAP initiation (Olsen et al., 2010), long-term care (Epstein et al., 2009) and interventions to foster adherence (Campos-Rodriguez et al., 2016). One might therefore anticipate a relationship between practitioners' beliefs regarding the determinants of CPAP adherence, and the adherence-promotion actions they reportedly use in clinical practice. However, implementing research findings into clinical practice in a complex treatment situation such as CPAP treatment (Ward et al., 2014) can often be difficult. Our second-order structural equation model showed that only one of three determinant factors (i.e. knowledge) was predicted clinical practice, influencing the adoption of educational and informational actions. We also found that the practitioners rated absence of anxiety as an important determinant of patient adherence. Yet, treatment of anxiety was not a frequently adopted action. One possible reason for this seemingly contradictory finding is that actions perceived as suitable by the individual practitioner might be influenced by factors beyond the immediate control of the practitioner (e.g. time constraints, local traditions, or the physician in charge at the clinic; Karlsson et al., 2015). In this way, practitioners' actions may not reflect their personally held beliefs regarding how to best promote CPAP adherence. CPAP practitioners may have clear ideas about which factors affect CPAP adherence, but lack the decisional latitude to determine all aspects of their actual clinical practice. This is supported by our finding that knowledge did not predict medical actions. However, the relatively low response rate in the present study (i.e. 53% and 51% of all practitioners in Sweden and Norway, respectively) prevented analyses for determinants and actions on an individual practitioner or centre level. Other aspects such as the patients' communication skills (Broström et al., 2017) might affect the actions chosen by practitioners. While few studies have directly observed communication between CPAP practitioners and patients with OSA, previous research has indicated that there is a difference between the views of CPAP practitioners and patients regarding patients' needs for information and ability to understand information with regard to OSA (Broström et al., 2009). Patients valued information about causes of sleep apnea more highly than did practitioners, and patients rated their ability to learn about CPAP and OSA as higher than did practitioners. Discrepancy between the views of patients and practitioners may affect how and which educational interventions are offered (Broström et al., 2017). It is important to further examine these reasons in future exploratory studies including both practitioners and patients, as these differences may have a negative impact on clinical practice. Evidence-based practice is typically depicted as an intersection of three knowledge sources: the evidence (i.e. empirical research support), practitioner experience and expertise, and patient preferences and values. Descriptions of evidence-based practice add a fourth element, in the form of the context in which health care is provided (Nilsen, 2015). The generally weak relationships that we observed between perceived determinants and practitioners' actions imply that context and patient factors may have a strong influence on clinical practice.

Another possible reason for the limited association between hypothesized determinants and actions is that the content of interventions used in research studies to improve CPAP adherence tends to be unclearly described. Many studies also fail to make clear the theoretical "how-and-why" assumptions that underlie interventions (Wozniak et al., 2014). These shortcomings mean that potential information from such studies about true determinants, and effective adherence-promotion actions, may not be readily available to stakeholders and CPAP practitioners. This may hinder efforts to subsequently reproduce and improve the effectiveness of these interventions into clinical practice. It can also hinder implementation, as adopting an intervention described in a study typically requires some adaptation of the intervention to a local clinical setting. It is difficult to determine which intervention elements should be amended or adapted, and how to retain and translate effective

interventions into new settings (Nilsen, 2015), without understanding the exact content of an intervention. Another explanation for the poor association observed between determinants and actions may lie in deficits in knowledge regarding the true determinants of CPAP adherence, and which interventions may be effective in promoting adherence (Karlsson et al., 2015). In the absence of knowledge regarding what predicts CPAP adherence and how it might best be promoted, CPAP practitioners may be unable to translate their knowledge regarding determinants into actions.

Study limitations must be acknowledged. This national survey aimed to recruit all CPAP practitioners in Sweden and Norway. Despite reaching 93% of all CPAP centres in Sweden, the generalizability of the results is limited by the relatively low individual-level response rates, which were evenly distributed over all centres, in both countries and a low centre-level response rate in Norway. Guidelines, and economical and organizational aspects/routines at a centre are some of the things that can affect how a practitioner practices (i.e. respond to the questions). It is therefore possible that practitioners from the same centre may share practice, homogenous responses can occur, creating a clustering effect here that was not considered. However, implementation of evidence-based practice (i.e. guidelines) is difficult and individual habits can occur. Our intention is that the text in the discussion should describe these aspects. Still, a more serious limitation to the current study is that, despite the second-order structural equation model providing an adequate fit to the data, it explained only 25% of variance. One explanation for this might be that the study relies on self-reported data from practitioners only. Practitioners may have failed to accurately recall their true actions, and some may have provided inaccurate but socially desirable responses, in an attempt to show their own clinical practice in a positive light (Paulhus, 2002). Objective CPAP adherence data, and patients' reports of the interventions that they have received, were not collected in the current study but could usefully be included in future studies.

In conclusion, a variety of determinants and actions were considered important, and were frequently used by practitioners to support adherence. However, knowledge was the only perceived determinant of CPAP adherence that influenced clinical practice. Educational and informational actions were associated with the medical actions used by the CPAP practitioners, but practitioners' beliefs in the importance of knowledge, attitude and support in shaping adherence were not associated with the use of medical actions.

AUTHOR CONTRIBUTIONS

A. B.: draft, analysis, preparation of ms; A. P.: analysis, preparation of ms; P. N.: preparation of ms; B. G.: preparation of ms; M. U.: draft, analysis, preparation of ms.

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